NUJHS Vol. 2, No.1, March 2012, ISSN 2249-7110
Nitte University Journal of Health Science

Short Communication

FIBONACCI SEQUENCE IN FLEXION-EXTENSION COMPLEX OF INDEX DIGIT

Arunachalam Kumar
Professor of Anatomy, K. S. Hegde Medical Academy, Nitte University
Mangalore - 575 018

Correspondence :
Arunachalam Kumar
Phone : 0824-2204490 E-mail : dean.kshema@nitte.edu.in

Abstract :
Flexion and extension of are simple to and fro movements of the digits. The articulations producing the fully extended or flexed finger are simple condyles. Analysis of the kinetics of the exercise shows that despite its seemingly rudimentary biomechanical sortie, flexion-extension of the fingers follows a characteristic mathematical precision and geometric equilibrium, circumscribing a cochlea spiral. Moreover, linear measurements of each osseous elements of the individual digit show a sequential series of increments in dimension, a rise that strictly adheres to the Fibonacci ration. To exemplify the principles of motion, this brief paper describes the movements at example this study describes the flexion-extension complex of the index finger of the hand.

Keywords : flexion-extension, index, Fibonacci, Rotation, Kinetics, Biomechanics

Introduction :

The human hand is a biomechanically efficient functional unit. The manus is a complex made up of a score of intrinsic muscles, twenty seven individual osseous elements articulating through a series of joints. With inputs by ligaments, tendons, bursae assisting the movements, the hand is indeed a marvel in kinetic engineering, Gifted through evolution to perform the 'opposition' exercise, the phalangeal, metacarpal, and carpal condylar, saddle and gliding plane joints of the palm flex, extend, abduct and adduct[1].

Prone to injury and malfunction, the loss of 'man days' due to hand lesions, cause serious economic loss to industry and economy in many agrarian and industrial nations. Much analytical work has been done by kinesiologists on the function and disabilities of this often used component of the upper limb. In this brief paper we present yet another interesting observation on the biomechanics of the digit.

Materials & Methods :

To scale measurements were made of the shadow of a supine hand during performance of simple flexion and extension of the digits, especially, the index. The shadow of the arc described by the exercise in the form of excursion of the flexing index tip projected on a wall mounted white screen board was traced. The resultant arc was analyzed and linear measurements (in mms) of each individual bone element were recorded, from distal phalanx to base of second metacarpal for index digit.

Mathematical models from values obtained were graphically reproduced through Computerized Assisted Designing (CAD).

Observations :

Measurements of individual bones show that, despite the soft tissue elements that bar precise and accurate measures, the interarticular distances between the distal, intermediate, proximal phalanges and the metacarpal ends, repeat the Fibonacci sequence. That is the lengths were 17 mm, 28 mm, 45 mm and 72 mm respectively. Put in Fibonacci sequence series, 17 +28+42+73, or at every joint an increment of 1.6 to 1 was evident (Figures 1 & 2).

Up to 120 mms., the arc described by the index tip shadow forms a cochlear spiral pattern, beyond which it becomes erratic (chaotic). Flexion at index interphalangeal, metacarpopahalangeal joints spiraled across a hub or axis, which was horizontally mobile for about 10 mms in a complete range of flexion-extension.

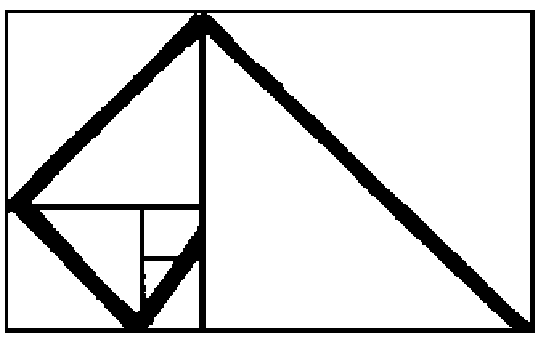
Taking the midpoint of the axis, as referral point, when the arc was plotted through CAD, the spiral created displayed a splayed-out form, akin to the molluscan shell.

Measurements at fixed reference points along the spiral show a progressive increment at angulation or its reverse, in extension and flexion of index. Approximately, the increment followed the 'golden mean' ratio first enunciated by the European mathematician, Fibonacci, centuries ago, which is around 1: 1.63 (Figures 3 & 4).

Discussion :

The need for better utilization of biomedical devices and mathematical models, coupled with a more comprehensive interdisciplinary input, could lead to more understanding, and there-from, a better rehabilitation, of the kinetics of the human hand [2,3]. The two measurements presented here demonstrate that function follows precise mathematical formulae, and that such mathematically sound base for movement is probably directly related to the ratios, in the very construction of the skeletal components.

Comparing such recreated spirals drawn from disabled or treated hands, to normal ones, could aid the rehabilitation physiotherapy procedures [5,6]. It is quite evident that a normal hand functions in a synchronized and predictable mathematical model[4], a fact of much significance to biomedical engineers.



FIBONACCI - FRACTAL RATIO 1 : 1.6

Figure 1: The geometrical proportions of individual bones of the hand

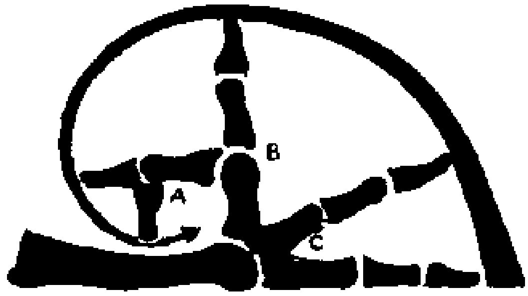


Figure 2: The cochlear spiral configuration of index tip during extension-flexion

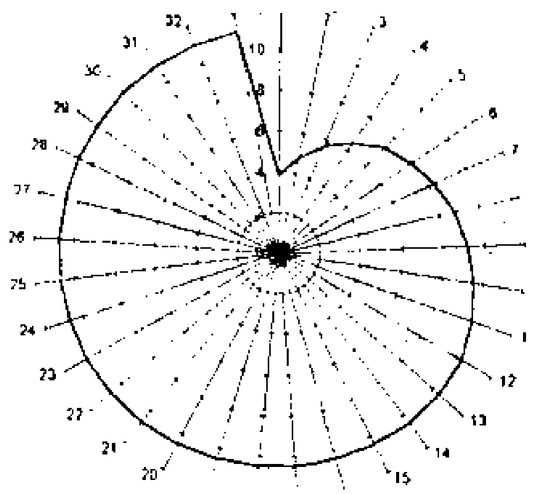


Figure 3: CAD plot of arc produced by flexion- extension of index digit

References :

1. Arunachalam Kumar
   The Index digit rotation and opposition evolution
   Human Races Monthly, Vol. 1, No.9, 2002
2. Rao A & Arunachalam Kumar
   Mathematical Analysis of Flexion-Extension of Index Digit
   Proceedings of the N.C.B.E., Ed. Niranjan UC, VIII 21, 1998
3. Manou J & Arunachalam Kumar
   The Rotational Kinetics of Index-Pollex in Opposition Exercise
   48th A.S.I. National Conference, Manipal, 2001
4. Rao A & Arunachalam Kumar A
   Opposition Biomechanics: A Community Study
   Procedings of the National Conference on Biomedical Engineering, Ed. Niranjan UC, Manipal, 1998
5. Rao A & Arunachalam Kumar
   Mathematical Analysis of Flexion-Extension of Index Digit
   Proceedings of the N.C.B.E., Ed. UC Niranjan, VIII 21, 1998
6. Savita S & Arunachalam Kumar
   The Thumb-Index Complex Biomechanics in Opposition
   XIV Conference of Indian Society of Hand Surgeons, Manipal, 1990
7. Arunachalam Kumar
   Complementary Rotation of Index in Thumb-Index Opposition
   Proceedings of the International Conference of Biomechanics & Clinical Kinesiology of Hand & Foot, Eds. Patil K M & Srinivasan H, IIT Madras, 1985